

Improving Inpatient Glycemic Control: Utilization of Daily Pharmacist Monitoring and Intervention

Honors Thesis

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April 9, 2017

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A handwritten signature in black ink that reads "William Joshua Guffey". The signature is written in a cursive style with a large, stylized 'W' and 'J'.

Abstract

As a directive of the Hospital Engagement Network 2.0 and in order to improve patient care, CHS NorthEast undertook project to improve glycemic control, specifically to reduce overall incidence of hypoglycemia and hyperglycemia. The primary overall goal was reduction of incidence of hyperglycemia via utilization of pharmacist or pharmacy extender chart review. In addition to this, incidence of hypoglycemia was also tracked to ensure the percent of patients experiencing hypoglycemia remained low. The project took place in three main phases, the baseline data collection and proposal phase, the student TheraDoc intervention phase, and the interdisciplinary rounds phase. Over the course of one year, glycemic control was improved in the targeted units within the hospital. The student phase showed modest improvements, while the interdisciplinary rounds phase demonstrated a more dramatic improvement.

Introduction

The ADA guidelines recommend the use of an insulin regimen including basal, nutritional and correction components for patients with diabetes who are admitted to the hospital.¹ Quite often the regimen does not include all three components. Some barriers to this may include number of insulin administrations, simplification of orders, uncertainty related to patient's home diabetes medications, and fear of hypoglycemia. Despite the fear of severe adverse effects due to hypoglycemia, a well-structured insulin protocol can mitigate the risk of this occurring. Hyperglycemia is associated with a number of negative outcomes such as increased inpatient complications, ventilator days, ICU and hospital length-of-stay, and an overall increased cost.²

Carolinas HealthCare System (CHS) was part of a group of 17 hospital systems called the Hospital Engagement Network 2.0 (HEN) to take part in a grant program funded by the Centers for Medicare and Medicaid Services that sought to reduce all-cause preventable harm to patients. One goal of this program that CHS established was to reduce all out-of-range point-of-care (POC) blood glucose measurements by 40% from baseline. The range was defined as any value < 70mg/dL and >179 mg/dL. This goal was assigned to all hospitals within CHS, including CHS NorthEast, a 457 bed hospital in Concord, NC. A baseline period was measured in 2015 and found the total percentage of out-of-range values at NorthEast to be ~38%. The 40% reduction goal was calculated to be ~22.7% by the end of the HEN 2.0 trial period, October 2016. A previous intervention was effective in reducing incidence of hypoglycemia. Because of this, and the fear of severe negative outcomes associated with hypoglycemia, there was some push-back among providers against the idea of initiating more aggressive therapy for hyperglycemia.

The project was mainly driven by the pharmacy department. Other stakeholders included the diabetes educators, physicians and nurses. Various committees throughout the hospital and healthcare system were aware of the goal and the attached grant.

Methods

An initial assessment of baseline data was conducted for the months November 2015-January 2016. The goal was to identify possible problem areas and potential target areas for intervention. The assessment phase lasted from January to March 2016. In April the results were presented to the various shareholders including physicians, pharmacists, nurses, hospital administrators and diabetes educators. There were three specific presentations given to the NorthEast Diabetes Care Team, at the April Carolinas Hospitalist Group (CHG) monthly meeting, and finally to the Performance Improvement/Patient Safety Committee meeting, which included the CMO. After each presentation, feedback was gathered and potential interventions were modified accordingly. Following this period, the specific final interventions were defined.

The first would be a three-month trial period of student monitoring of glycemic control in one particular 15 bed general medicine unit called “Med 1.” May 2016, the first month, was a pilot phase that was used to train 4th year pharmacy students and identify complications and confounders. June and July 2016 were the months of the live student intervention phase. Students were trained to use TheraDoc, a clinical surveillance software. TheraDoc was and is used by CHS pharmacists in the Antimicrobial Stewardship Network teams and in the Virtual Critical Care Units.

Students received daily alerts for any POC blood glucose check that was > 179 or < 70 for a patient in Med 1 (User Protocol in appendix). Each morning, students received alerts for patients who had POC blood glucose readings that were outside the acceptable range. The TheraDoc software allows the user to analyze labs and trends as well as medications. In addition to the alert, students used charting for the patient to assess for potential therapeutic modifications. Students could then propose an intervention if an intervention was necessary. The initial proposal was given to the pharmacy preceptor, and then to the physician, in person or over the phone. Student interventions could be cataloged according to two dimensions of the proposal; the first was related to administration and dose and the second was related to the type of insulin. The type of insulin that could be adjusted was either “basal,” “bolus,” or “correction.” Doses could be “initiated,” “modified,” or “reduced.” Any combination of the two dimensions was allowed, for example “initiate basal insulin” or “modify correction insulin.” Following the proposal to the physician, the result was logged as either “accepted,” “accepted – modified,” or “rejected,” depending on the result. Patient medications were allowed to be modified on multiple occasions, for example, a proposal could be made to “initiate bolus insulin” one day and then “reduce (modify) sliding scale insulin” the next day.

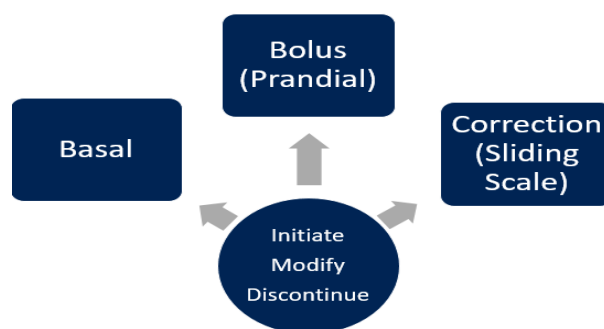


Figure 1: Possible intervention options. Students propose an intervention to initiate, modify or discontinue any component of a patient's insulin regimen. “Modify” could include increases or reductions.

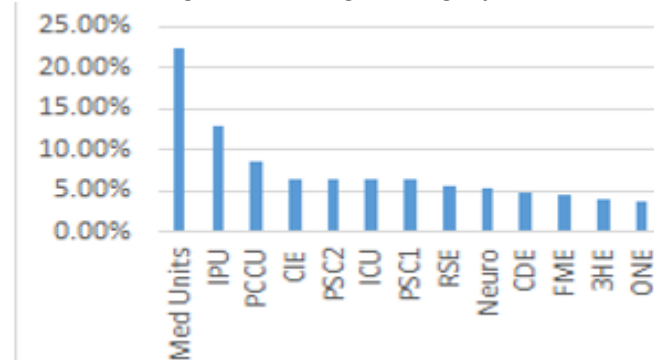
No students were on rotation in August 2016 since the pharmacy residents were going through training during that month. The second intervention was initiated from August and going forward indefinitely. Interdisciplinary rounds were restructured in Med 1, Med 2 and Med 3 to include a clinical pharmacist plus a 4th year pharmacy student and/or a pharmacy resident. Pharmacy representation in interdisciplinary rounds covered a variety of therapeutic monitoring including drug interactions, anticoagulation, antimicrobials, IV to PO conversion, renal dosing adjustments, and glycemic control among other things. Proposals could be made during interdisciplinary rounds which included providers, nurses, social workers, diabetes educators and pharmacy. They did not use TheraDoc during this phase, but instead worked up each patient individually. These rounds have been ongoing since this initial phase.

Out-of-range POC readings during all months of the HEN 2.0 period were excluded within the first 24 hours of hospital admission, and within 2 hours of another alert. The rationale for this was to give providers time to correct dysglycemia from prior to admission, and to reduce the impact of repeated measurements during a period of intense dysglycemia from skewing the data. The same criteria were used for the baseline data.

Results

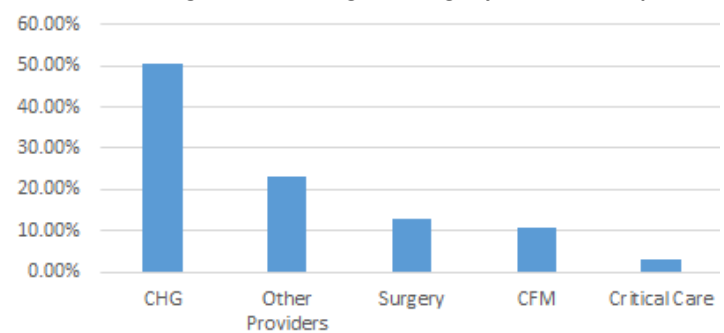
Data from the baseline period of November 2015 to January 2016 were used to target interventions that might lead to the greatest effect. The data were broken down by a variety of characteristics, including provider group, hospital unit, patient demographics, and others. There were a total of 12,742 out-of-range readings during the baseline months. This number came from 1,288 different patients. Within those patients with readings > 179mg/dL, the top 10% of patients made up 40% of the readings. A large number of patients (29% of the group) had only 1 or 2 high readings. Approximately 93% of all of the out-of-range POC were due to hyperglycemia. The hospital unit with the highest percentage of out-of-range readings was the med units Med1-Med3 (Table 1). Most of the other hospital units had a fairly even distribution of out-of-range readings, accounting for between 4-8%. The provider group with the highest percentage of readings coming from patients under their care was Carolinas Hospitalist Group (Table 2). Approximately 50% of the readings came from CHG patients.

Table 1: Percentage of Out-of-range Readings by Unit



Med Units: General Medical/Surgical Units; IPU: InterPulmonary Unit; PCCU: Cardiac Care Unit; CIE: Cardiac Unit; PSC: Post-surgical Care Unit; RSE: Renal/Dialysis Unit; CDE/FME: Family Medicine/Clinical Decision Units; ONE: Oncology

Table 2: Percentage of Out-of-range Readings by Provider Group



CHG: Carolinas Hospitalist Group; CFM: Cabarrus Family Medicine

Due to a variety of factors, including the small number of patients in each unit, there was considerable variability from one month to the next. With regard to the raw percent of out-of-range numbers for the three time frames, there does seem to be a downward trend in the percentage of out-of-range readings. In the pre-interventional phase of January through April, the average out of range readings was 57%. During the student phase of May through July, the average was 53%, and during the interdisciplinary rounds phase of August-December the average was 35%. There is certainly a steady trend toward a decline in hyperglycemia over the course of the year (Figure 2, Table 3).

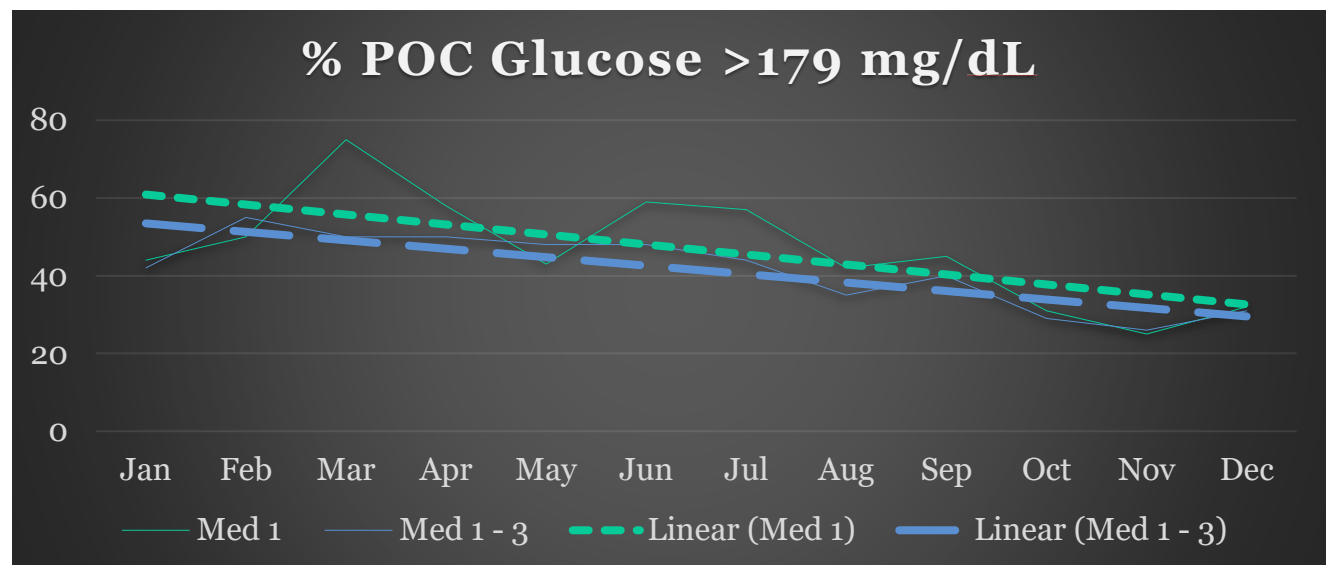


Figure 2: Percentage of hyperglycemic readings for Med 1 only (green line) and Med 1-3 combined (blue line). Dashed lines represent overall trends for the year.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
M1 % > 179	44	50	75	58	43	59	57	42	45	31	25	32
M1-3% > 179	42	55	50	50	48	48	44	35	40	29	26	31

Table 3: Numerical representation of percentage of hyperglycemic readings

During HEN 1.0 there had been considerable progress at CHS NorthEast with regard to incidents of hypoglycemia. A major concern with all of the stakeholders was that any reduction in incidents of hyperglycemia would not increase the incidents of hypoglycemia. The trend for hypoglycemia roughly follows that of hyperglycemia, with variation throughout the year, but an overall reduction from start to finish in both Med 1 and all of the med units (Figure 3).

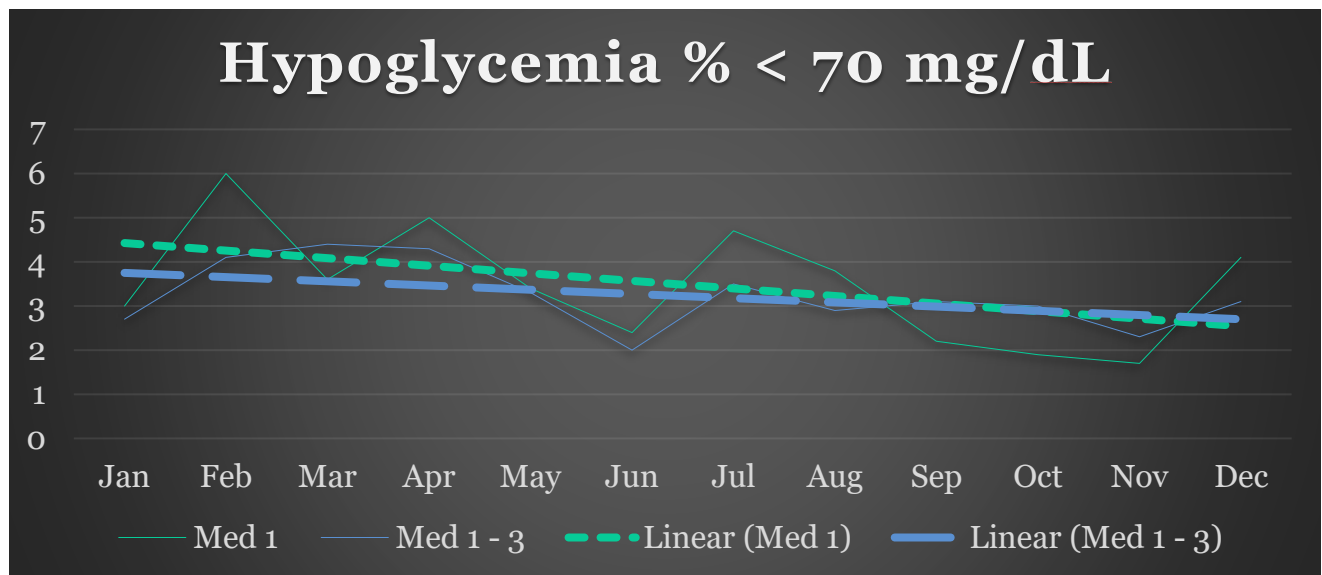


Figure 3: Percentage of hypoglycemic readings for Med 1 only (green line) and Med 1-3 combined (blue line). Dashed lines represent overall trends for the year.

Students initiated 114 total interventions, 20 of which were accepted and implemented. The majority of accepted interventions were to initiate bolus insulin, followed by initiating basal insulin (Figure 4). A large number of potential interventions were never implemented either due to actual patient discharges, or potential patient discharges that did not happen until a later date. Other factors that accounted for interventions that were not accepted included patient transfers to other units and dysglycemia that was corrected prior to intervention.

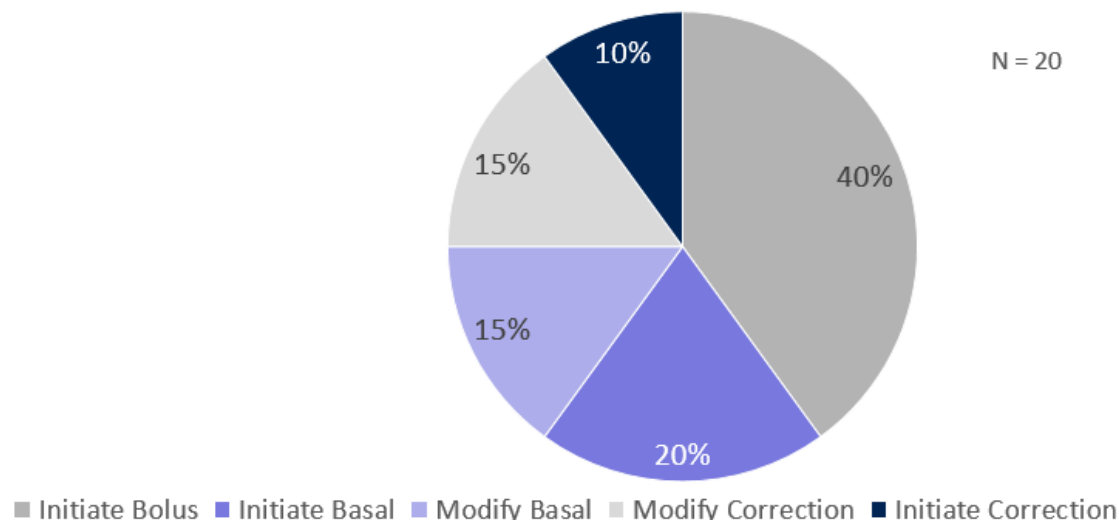


Figure 4: Types of accepted student intervention by percent

Discussion

The decision to target Med 1 for intervention was due to a variety of factors. Looking at the baseline data it was clear that the areas with the highest percentage of out-of-range readings were the med units, and patients under the care of CHG physicians. With limited time and resources, any intervention would have to be targeted for the greatest return on investment. The decision to try interdisciplinary rounds came partly out of the observation of outstanding glycemic control in the ICU. Despite having the sickest patients in the hospital, the ICU accounts for a disproportionally small percentage of the elevated POC glucose readings. This may be due to the fact that the ICU has well-established, meaningful interdisciplinary rounds in place that serve to control a number of potential problems, including dysglycemia.

Overall, the trend was toward improvement of glycemic control over the intervention period and beyond. The goal of a 40% overall reduction was not achieved during the HEN 2.0 timeframe, and has still not been achieved, although percentages in recent months are approaching the 22% mark.

At the beginning of the project there was strong support among some providers for using sliding scale insulin as the primary therapy for most of the patients. There were several reasons expressed for this. One was that many patients have a brief stay in the hospital, or transfer units rapidly. The idea is that using sliding scale can keep blood sugars from getting too high while they are admitted, and then the patient can go back on their home regimen. The main concern was that using the full hospital protocol as written could lead to overdoses of insulin and hypoglycemia. During a previous improvement grant, HEN 1.0, the focus had been on reducing incidents of hypoglycemia in particular. The staff at NorthEast was very successful with this goal, reducing the overall rate of hypoglycemia to 2.1%. Even though this was a positive goal, it may have contributed to a conservative approach to hyperglycemia in order to avoid hypoglycemia. It is possible to reduce hyperglycemia without significantly increasing hypoglycemia, and efforts should be med to reduce both. Indeed, during the study period there was actually a reduction in the rate of hypoglycemia, even though the rate of hyperglycemia improved

dramatically. Providers became more comfortable with initiating at least basal and correction insulin, as well as prandial insulin as well in many patients.

There were several limitations of this particular study. The most important were probably the limited timeframes for the interventions, and the small size of the interventions. The student TheraDoc period was especially short in duration and only involved a 15 bed unit. There is considerable variability in glycemic control, even prior to the initiation of the intervention. Unfortunately factors such as student schedules and workload limited the scope of this intervention. Students were only on rotation for a month at a time, and only from 07:00 to 15:00 M-F, so were only able to make interventions during that time. Four different students participated in the study and there were differences in number of interventions made by each student. During the study period, NorthEast did not assign physicians to particular units, which made interventions difficult on a practical level. In the past few months the hospital has made the decision to transition to having physicians cover specific units, which increases the likelihood of making an in-person recommendation, particularly at rounds.

Despite the limitations, blood glucose readings appear to be under much better control. This has taken place within a fairly short period of time. The interdisciplinary rounds seem to have had the largest, and most sustained effect. The students who used the TheraDoc alerts did find them to be useful for targeting specific interventions. The software is easier to use than the hospital charting system Cerner and students were able to identify and formulate interventions quickly. A possible future strategy would be to combine both interventions, that is to use TheraDoc alerts for interdisciplinary rounds. This could be used not only for glycemic control, but also for the other things that are monitored such as antimicrobials, anticoagulation and various laboratory parameters. With the help of pharmacy extenders, such as APPE students, this could become a regular addition to the pharmacy service. A major limitation of either intervention is the inability to scale up to cover the whole hospital. A little more than 50% of the beds in the hospital are covered by pharmacy representation at interdisciplinary rounds. Increasing this number would likely require more students, residents, and/or increased pharmacy FTE.

There are countless variables that affect glycemic control in the hospital. This project was limited by a quick development phase, a short overall duration, and a limited group of patients receiving the intervention. With all of that taken into account, the results from the med units, particularly since the initiation of interdisciplinary rounds is impressive. Adding more targeted pharmacy oversight to glycemic control can be beneficial with regard to several outcomes, including length of stay, patient health, and cost to the patient and healthcare system. Utilization of pharmacy extenders and surveillance software are potential options for increasing the reach of pharmacy into patient care.

Acknowledgements

This project never would have been possible without the assistance of Dr. Becky Szymanski, who helped organize and oversee every aspect of the project. Dr. Josh Guffey helped initiate the project, provided advice throughout, and helped with logistical issues such as poster preparation and thesis evaluation. Nicole Free, Victoria Everette and Jamie Rembert were the other students who took time away from their many responsibilities to monitor the alerts and propose interventions. Many of the clinical pharmacists at NorthEast helped students make interventions, including Dr. Tina Hipp and Dr. Kevin

DeSanty. I am grateful to the entire UNC Honors Seminar, particularly to Dr. Phillip Smith who has provided advice and coordinated the entire seminar. Finally, this project would not have been possible without the support of my wife and family during the many days and nights that I was away from home working on this project.

Appendix

TheraDoc Protocol

- (1) Sign-in to TheraDoc at <http://dcr-tdaw-ms-01/theradoc/index.cfm?sid=0&view=0>
- (2) Each morning (only once daily) click "Export to Excel" and save in Computer → Shares (X) → CMC NE pharmfiles → Joel Bibby PS → TheraDoc Reports (save as excel file type)
- (3) Review each patient profile and make a therapeutic decision.
 - a. Click the patient name
 - b. Click the EZ alert below
 - c. Click the bold patient name to bring up the patient window in a new tab

The screenshot shows the MyChart patient portal interface. A red box highlights the 'EZ Alerts' section, with three red arrows pointing to specific elements:

- a.** Click the patient name (pointing to the patient's name in the 'EZ Alerts' list).
- b.** Click the EZ alert below (pointing to the 'EZ Alert: Hb A1C' entry).
- c.** Click the bold patient name for new tab (pointing to the patient's name in the 'EZ Alerts' list).

The interface includes a sidebar with navigation options like 'Home', 'My Health', 'My Medications', and 'My Appointments'. The main content area displays the patient's profile, including their name, date of birth, and gender. Below this, there are sections for 'EZ Alerts' and 'EZ Alerts by Hb A1C'.

The 'EZ Alerts' section shows a list of alerts, including 'EZ Alert: Hb A1C' and 'EZ Alert: Hb A1C (Hb A1C)'. The 'EZ Alerts by Hb A1C' section shows a table of results, including 'Glucose (Fasting Blood)' and 'Hb A1C'.

The 'EZ Alerts by Hb A1C' table has the following columns: 'Glucose (Fasting Blood)', 'Result', 'Source', 'Collected', 'Result (Status)', 'Accession #', and 'Ordered Provider'. The table contains one row of data for 'Glucose (Fasting Blood)' with a result of '114 mg/dL (Hb A1C)'.

- d. Propose intervention to a pharmacist and/or Angela Charles, Diabetes Educator
- (4) To log an intervention
- a. Dismiss all old alerts for a given patient (these are green and are below the current blue alert)
 - b. Click "intervention" a new window will pop up
 - c. Click "clinical activity" in the new window

Admit Diagnosis: CELLULITIS, DIABETIC ULCER OF LEFT FOOT;HIGH BP/CHILLS/ HX OF HEART
SCr: 1.25 mg/dL (06/28/2016) **Height:** 72 in (182.88 cm) (06/27/2016)
CrCl: 89 mL/min(Cockcroft-Gault; weight used--90 kg) **BSA:** 2.76 m²
Attending: COFIELD, KATRION PHYSICIAN (06/27/2016)
Admit Date: 06/27/2016 20:23
Allergies: Risperidone [Agitation] (06/27/2016) *, penicillin (Swelling) (06/27/2016) *
 ALL INSTITUTION DATA

INTERVENTION ASSISTANT™

[New View ▾](#)
[edit](#)
[new](#)
[delete](#)
[Adverse Drug Event](#) | [General](#) | [Clinical Activity](#)

Mark selected as: **Intervention Status:** ▾
 Follow-up Status: ▾

DATE ENTERED	PATIENT	CURRENT LOCATION	INTERVENTION TYPE	ASSIGNED TO	INTERVENTION LOCATION	ENTERED BY
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Clinical Activity Review Data: **General Labs** **GO** **Cancel** **Finish** **Next >>**

Activities 1 of 3

Intervention Date

06/28/2016 15:32 (03:32 PM)

Location

☒ Inpatient ☐ Outpatient

N1E **NORTHEAST**

Activities

Remove All **Search**

Clinical Activities

- ▶ Stewardship (27)
- ▶ ID Consult (30)
- ▶ VCC Team (6)
- ▶ HEN Team (1)
- ▶ ADE Prevention (7)
- ▶ IV to PO Conversion (8)

- d. Click "HEN Team"
- e. Click "glucose management" on the next screen (only option)
- f. Click the box next to appropriate intervention, including "no intervention needed" for patients who are being d/c'd or BG has improved etc.
- g. Log each separate intervention separately, do not click more than one box. For example, if you added basal and pre-meal insulin, go through this process twice for the same patient.
- h. Click "next"

Clinical Activity Review Data: **General Labs** **GO** **Cancel** **Finish** **Next >>**

Activities 1 of 3

Intervention Date

06/28/2016 15:32 (03:32 PM)

Location

☒ Inpatient ☐ Outpatient

N1E **NORTHEAST**

Activities

Remove All **Search**

<input checked="" type="checkbox"/> Initiate basal insulin dose (HEN)	<input checked="" type="checkbox"/> Initiate basal insulin dose (HEN) <input type="checkbox"/> Increase basal insulin dose (HEN) <input type="checkbox"/> Decrease or discontinue basal dose (HEN) <input type="checkbox"/> Initiate pre-meal short acting insulin (HEN) <input type="checkbox"/> Increase pre-meal short acting insulin (HEN) <input type="checkbox"/> Initiate SSI therapy (HEN) <input type="checkbox"/> Increase SSI dose (HEN) <input type="checkbox"/> Decrease SSI dose (HEN)
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Comments to Team Member 0/4000

Receiving Provider

Savings
 \$0.00

Comments to Provider 0/4000

- i. Type in comments related to the intervention you made, just a sentence or two describing what you did and rationale
- j. Select receiving provider
- k. Click next
- l. You can either save the intervention as "pending" if you need more time, or enter the intervention when the situation is resolved and mark it as "complete"
- m. Select the appropriate intervention status ("cancelled" would only be if we decided to get rid of it, I don't think Victoria or I ever did this)
- n. Click submit and you're done!

Intervention Date	06/28/2016 15:32
Sender	BSEBY, JOEL
Assigned To	BSEBY, JOEL
Receiving Clinician	
Intervention Location	NORTHEAST - MLE
Activities	Initiate basal insulin dose (HEN)
Follow-up Status	Complete
Intervention Status	Undetermined
Comments to Team	Undetermined
Comments to Provider	Accepted
	Accepted Modified
	Cancelled
	Rejected

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